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The Movement of Volcanic Dust over the Globe

By C. E. P. BROOKS, D.Sc.

A violent volcanic eruption, accompanied by the emission of large quantities of ash, began in the Andes of South America on April 10th. From the descriptions in the press it appears that the volcanoes of Descabezado, Las Yeguas, Tinguirica, Quizapu and several others all about 36°S., emitted large quantities of dust and ashes, which fell steadily as far east as Buenos Aires and Montevideo, a distance of 800 miles. Shortly after the news of the eruption reached London, the question was widely asked, how soon would the veil of volcanic dust reach England, and what phenomena could be expected when it arrived. The following notes attempt to indicate the probable answers to these questions.

The greatest volcanic eruption which has been studied in detail is that of Krakatoa on August 26th-27th, 1883. Krakatoa is a volcanic island in the Sunda Strait between Java and Sumatra, in latitude 6°S., 105°E.; after remaining dormant for nearly two centuries it became active again about 1880, a series of minor outbursts culminating in a violent explosion which blew more than half the island to pieces. The volume of dust and ashes has been calculated as 16 cubic kilometres, and even before the great explosion the column of water vapour and dust was ejected to a height of between 27 and 33 Km.,

(98396) 107/27 1,075 5/32 M. & S. *Gp.303*

where it spread out laterally in a gigantic black cloud, completely hiding the sun in the neighbouring parts of Java and Sumatra. From this cloud a rain of dust and ashes fell over a considerable area in the Indian Ocean, extending about 1,500 miles to the west and 1,200 miles to the south, but only a short distance to the north and east. Beyond the limits of appreciable dust fall, a series of optical phenomena were observed, including blue, green or otherwise coloured suns and moons, brown coronæ round the sun (" Bishop's Ring ") and vivid red and yellow sunsets and afterglows.

These phenomena were not seen immediately, however, but spread over the world in a more or less orderly manner, obviously following the distribution of the dust by the upper currents of the atmosphere. Immediately after the eruption, two main currents showed themselves. One series of optical phenomena travelled directly towards the north-north-east, reaching Japan by August 29th or 30th, the calculated speed being 39 m.p.h. The other, and vastly greater series of phenomena travelled directly westward near the equator. The first appearance of the blue suns, haze and sunset glows travelled at a speed of 81 to 84 m.p.h., but the main body of the haze, causing the most conspicuous phenomena, had a speed of only 72 to 76 m.p.h.. The equatorial Atlantic was reached about the end of August, and the sky glows continued until September 5th, after which there was an interval of nearly ten days before they recommenced. Evidently the main body of volcanic ash had passed over by the 5th, and during the interval it travelled completely round the globe before again reaching the equatorial Atlantic. The blue and green suns were seen for only a short period and only doubtfully outside the tropics. In the Pacific the interval between the first and second circuits was less definite, and evidently the dust cloud was rapidly elongating.

Isochrones of the spread of the main dust cloud and the vivid sunset glows are shown in fig. 1, which has been constructed from plates 35 and 36 of the official British description of the eruption.* The eruption began on August 26th; the isochrones marked August 31st and September 5th show the limits after five and ten days, and show the great rapidity of the westward movement. Apart from the branch over Japan there are only two departures from the almost straight course towards the west; a southward branch towards Mauritius and a northward one over Central America, both of which, as will appear later, correspond with well-marked lines of movement of cirrus cloud. There was in addition, however, a gradual spreading north and south over the whole tropical zone, shown by the

**Report of the Krakatoa Committee of the Royal Society.* London, 1888.

average limits of twilight glows during the first and second circuits of the globe:

	Atlantic Ocean	*Pacific Ocean*
First circuit	13°30′N.	22°N.
	16°50′S.	16°S.
Second circuit	About 24°N.	
	About 36°S.	

The gradual extension northwards and southwards continued

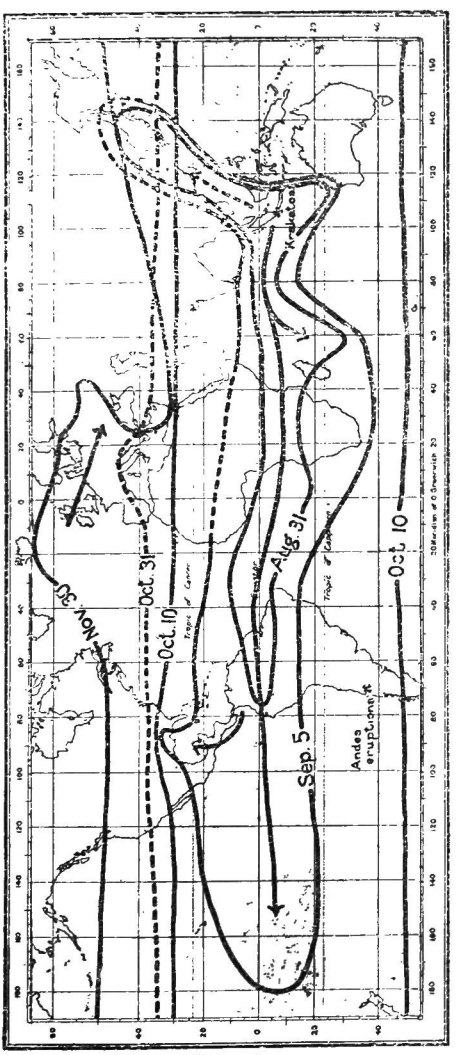


FIG. 1.

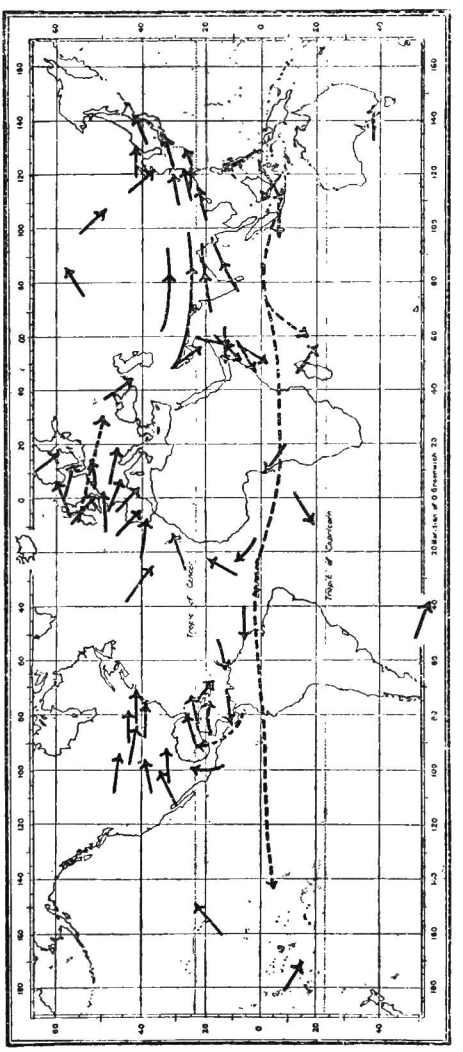


FIG. 2.

until about the end of October, as shown by the limits for October 10th and 31st in fig. 1, but after October 5th the spread was very slow, and it appears that by the time the dust cloud reached latitude 30° " it no longer possessed that due east to west direction by which at first its general motion within the tropics was so markedly characterised. Beyond this limit the facts relating to the march of the glows over North America, Europe and northern Asia show that the current which brought the glow-causing material . . . . carried it more from west to east than from east to west " (Report, p. 431). Their subsequent spread is described as follows*:

" Up to about November 23rd glows seen north of about 32° to 36°N. [such as that reported in Surrey on November 9th] were for the most part detached or sporadic." The dust responsible for these mostly drifted up from between south and west. " But about November 23rd a very remarkable movement took place in such a manner that the direction in which the main stratum progressed is not clear, in spite of a large collection of dates. Western Canada, British Columbia, California, and north-west Iceland, seem to have been first affected, and then in succession England, Denmark, France, Italy, Germany, Spain, Algeria. Austria, Turkey, Russia, eastern Siberia, and northern China. To distinguish sporadic from continuous glows is no easy matter. But a general view inclines us to regard this latter movement as taking place from west to east. An exact course cannot be determined, owing to the inequality in density and irregularity of outline of the great cloud. Excluding occasional displays, the glows were seen in the north-western parts of Europe about a week before they drew attention in the east and south-east. England, as a whole, was affected before Denmark as a whole, Denmark before northern Russia, northern Russia before Kiachta. North Italy and Lisbon, parts of France and Germany were affected on the 26th, south-east Iceland and a large part of western and central Europe on the 27th, part of eastern Europe on the 28th, southern Italy and Greece about December 1st."

The Bishop's Ring phenomena, which depend for their occurrence on the presence of a large number of minute particles of approximately the same size, did not reach their maximum development until April, 1884, by which time the larger particles may be presumed to have been removed by gravity. They remained visible until the spring of 1886, and appeared again after the eruptions of Souffrière in St. Vincent and Mt. Pelée in Martinique in 1902.

The course followed by the dust clouds provides a great deal of information about the movements of the air at high levels. The dust of August 26th reached a height of some

*London. *Q.J.R. Meteor. Soc.*, 14, 1888, p. 304.

30 Km., and the far more violent explosion of the 27th presumably went much higher. Observations of the afterglow give for the upper or middle part of the cloud a height of 37 Km. in August and 20 Km. in January. We can, therefore, regard the continuous arrows in fig. 1 as showing the air movements at a height of between 20 and 30 Km.. The temporary stream of dust towards Japan in the early days of the spread probably resulted from an air current at a lower level.

Fig. 2*, which has been compiled for me by Miss T. M. Hunt, shows by full arrows the general movements of cirrus and cirro-stratus clouds during the months of October to December. The average height of these clouds ranges from about 8 to 11 Km., or less than half the height of the upper part of the dust-cloud. Nevertheless the agreement between the main lines of figs. 1 and 2 is very close. The broken arrows, which show the main lines of drift of the Krakatoa dust, are inserted for comparison. The drifts of meteor trails, which occur at a still greater height, have no prevailing direction over Europe.

No other volcanic eruption of recent times has been followed by phenomena on anything like the same scale as that of Krakatoa. After the eruption of Katmai in Alaska on June 6th and 7th, 1912, the sky had a milky appearance over a large part of the northern hemisphere, and the power of the sun's rays was lowered appreciably, but there were no marked sunset phenomena. Evidence of the dust reached Algeria by June 19th and California by June 21st, but the data are insufficient to determine the movements of the dust cloud. No details seem to be available of the spread of the dust cloud from the West Indies in 1902, or of any remarkable sunset phenomena. Full details of the Andine eruption are not yet available, but their explosive violence does not seem to have been comparable with that of Krakatoa, and it is unlikely that the dust penetrated to such great heights in the atmosphere. It is to be expected that a milky sky, Bishop's Ring, and possibly sunset glows will travel eastward round the world in the southern hemisphere, but whether the British Isles will be affected is quite a different matter. The Krakatoa dust penetrated very slowly across the sub-tropical belts about latitude 30°. The Andine dust, starting in 36°S., would have to pass both these barriers as well as the equator itself, so that by the time it reaches our latitudes several months will have elapsed and the

*Compiled mainly from :

SHAW, SIR NAPIER. *Manual of Meteorology.* Vol. II, Cambridge, 1928.

BEMMELEN, W. VAN. The antitrades. *Nature, London.* 109, 1922, pp. 172-3.

HILDEBRANDSSON, H. H. Rapport sur les observations internationales des nuages au Comité International Météorologique. Upsala, 1903.

H. C. BANERJEE and K. R. RAMANATHAN. Upper air conditions over India and its neighbourhood up to the cirrus level during the winter and the monsoon. *Poona, India Meteor. Dept., Sci. Notes,* 3, No. 21, 1930.

mass will have become very attenuated. Katmai does not seem to have affected the southern hemisphere appreciably, and if, as seems likely, the recent Andine eruption was on a similar scale to that of Katmai, it is unlikely to affect the northern hemisphere, though this should not prevent a careful watch from being kept.

The Radiation Commission of the International Meteorological Committee and of the International Geodetic and Geophysical Union has issued the following circular :—

"In the middle of April there occurred in Argentina and Chile a series of violent volcanic outbreaks, which caused, according to descriptions given, a rich transfer of volcanic dust to the atmosphere.

With reference to the important results obtained through actinometric investigations in connexion with the great eruption of Mount Katmai in June, 1912, we take the liberty to draw your attention to the importance of detailed observations as regards the optical properties of the atmosphere at the present time, and beg you to join in favouring as much as possible the named researches.

We wish especially to recommend the following observations :

1. Actinometric observations as well of the total radiation from the sun, as of the radiation within selected parts of the spectrum.
2. Measurements of the diffused radiation from the sky.
3. Measurements of the atmospheric polarisation.
4. Measurements of the outgoing effective temperature radiation (nocturnal radiation).
5. Registrations with sunshine recorders.
6. Descriptions of the optical phenomena after sunset and before sunrise.

(Signed) J. MAURER, (Zürich) LINKE, (Frankfurt) A. ÅNGSTRÖM (Stockholm)."

The Splashing of Rain, with special reference to Evaporation Tanks

In an interesting article on "The Splashing of Rain" in the August, 1931, issue of this magazine, Lieut.-Col. E. Gold made some calculations of the height to which splashing might occur from a water surface. These calculations indicated that heights of the order of three or four feet might be reached; and in a note in this magazine for September, 1931, Mr. J. S. Dines gave an actual observation of splashing up to 2ft. 8in. It occurred to me that it would be very easy to obtain records in

actual rainfall, from any desired surface, by means of a simple "splashmeter" constructed as shown in the sketch. This instrument is so easy to make and to use that I give particulars in the hope that some readers of this magazine may be sufficiently interested to take observations at their own stations. It consists of a sloping board ($3\frac{1}{2}$in. x $\frac{1}{2}$in. material is suitable) supported on two uprights, one short and one long. It is important that a groove should be cut just inside each edge on the underside to prevent water creeping round from the top and vitiating the record. The underside is coated with coloured distemper, a material on which a splash of water makes a clear and permanent mark, and the edge or upper side is graduated to indicate the height of any point on the lower surface above

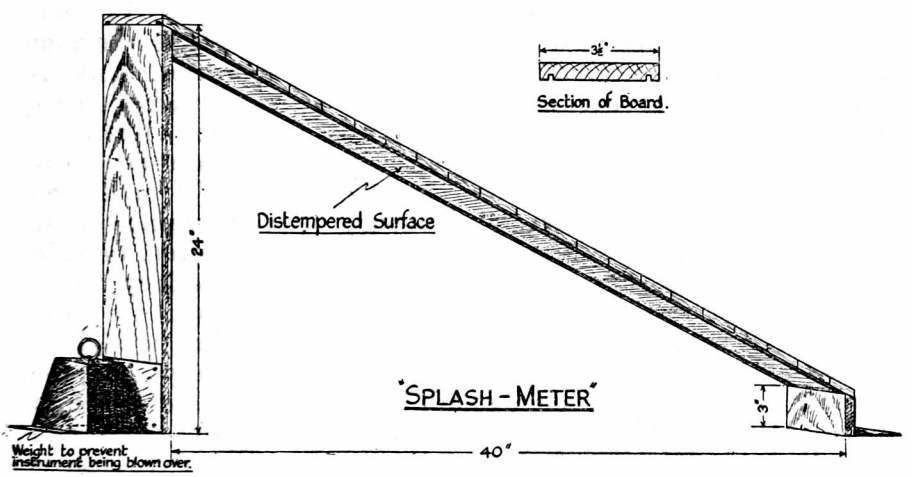


FIG. 1.

ground. In the instrument which I have made the range of heights is from 3 to 17 inches, but it would be desirable to increase the maximum height to about 24 inches.

Before taking an observation the underside is freshly coated with distemper and allowed to dry. The instrument is then put out on the grass or other surface under investigation while rain is falling. Any drops splashing upwards will strike the distemper surface and discolour it. After a few minutes exposure the instrument is brought indoors. An examination of the distempered surface then clearly shows the height to which splashing has occurred.

Up to the time of writing I have made only two observations, both on the asphalt surface of the roof of the Meteorological Office, South Kensington. During the time of exposure the roof was thoroughly wet and the instrument stood in what was virtually an extended shallow puddle. On the first occasion (March 22nd) in rain falling at the rate of 4 mm. per hour,

splashing up to 13 inches occurred. On the second occasion (March 23rd) in a heavier rain (at a rate of about 10 mm. per hour) one or two splashes reached 17 inches and there were numerous splashes up to 15 inches. I intend making further measurements as opportunity offers and to extend the investigation to include surfaces such as gravel, sand and grass.

This question of splashing is an important one in relation to rainfall measurements. It is of even more importance in connexion with the measurement of evaporation from a tank. To get a figure for the evaporation on a day when rain has fallen, the depth of rainfall as measured in an adjacent gauge is subtracted from the water level in the tank. This corrected level, when subtracted from the level read on the previous day, gives the value logged as evaporation. We assume, in fact, that the tank, acting as a rain-gauge, retains exactly the amount measured in an ordinary gauge. The evaporation tank is usually 6 feet square and its lip is about 3 inches above ground level. As a collector of rain it seems likely to be extremely efficient, but its open water surface obviously provides an ideal medium for out-splashing. We have seen that there is good reason for believing that splashing up to substantial heights occurs from a water surface, even in rain of moderate intensity. Consider for a moment a drop which splashes to a vertical height of 12 inches. Consider the drop simply as a projectile acted upon by gravity; the time of flight is 0.5 sec. If a wind of 12ft./sec. is blowing horizontally along the tank the drop, if sufficiently small, will be carried a distance of 6 feet before striking the water again. If the water were flush with the rim of the tank it is clear that no drop which splashed as high as 12 inches could fall back again into the water. Similarly it can be shown that there would be a loss of 70 per cent. of drops which reached 6 inches and of 50 per cent. of drops which reached 3 inches. In practice the water level is usually about 3 inches below the rim of the tank. We must, therefore, add three inches to all heights. A wind of 12 feet per second a few inches above the water corresponds with a wind of Beaufort force 5 or 6 as ordinarily estimated. It seems clear that in a strong wind there must be a very serious loss due to outsplashing when the tank is in an exposed situation. Unless this loss is balanced by insplashing (which is unlikely unless the tank is surrounded by some such surface as concrete or asphalt) the result would be an excessive figure for the "evaporation" on windy days with rain. This theory accords with some actual observations at Valentia Observatory which will, it is hoped, form the subject of a paper in *British Rainfall*, 1931.

E. G. BILHAM.

A Note on west-moving Depressions and on Cirrus Cloud Motion

This note is based on an examination of depressions which moved from some direction between south-east and north-east inclusive, which made a total westward progress of at least 400 miles (resolved towards due west), and which had closed centres passing over or near some part of the British Isles. In the last ten years only fourteen systems fulfilled those conditions. Eight of these had warm sectors on their right-hand sides during most of their motion, and moved in the same direction as the upper current. The remainder were surrounded with polar air, and had the strongest winds on their right-hand sides, so that they may be regarded as having travelled in the general current. In these cases the horizontal temperature gradients appeared to be small, so that there was probably no great change of wind with height. There are strong grounds for supposing that an easterly (or any other) wind current must be of the order of 15,000 feet or more in depth in order to carry along a disturbance. In a current only some 6,000 feet deep one can only detect very small irregularities travelling along the isobars, and then only for short distances.

The depressions with warm sectors are the most interesting, as they illustrate the importance of the temperature distribution for abnormal as well as for normal movements. They moved north-west or occasionally west, with warm sectors on their right-hand sides, consisting of continental air. In the region from England to central Europe they are commonest in the early summer, but round the Baltic they are more frequent later in the summer, when northern Europe is warm. They usually bring considerable rainfall, and frequently also thunder on the continent. On only one of the occasions in question did thunder extend to England, but if unclosed secondaries had been included there would have been several cases. The rain was preceded by high and then medium clouds moving from east or south-east, over a northerly current in the lower levels. Warm continental air has often enough moisture in it for heavy rainfall, provided that it can ascend far enough. Evaporation over land is likely to be an important source of moisture, since the mountains of southern Europe would remove much of any moisture brought from the Mediterrranean. Nevertheless a study of the air currents sometimes seems to indicate the Mediterranean as a source of moisture bringing rain (or snow) to England, not necessarily with a definite depression. If there is convergence in the circulation, the air may be moist even after it has crossed mountains. On the north side of the Alps there is sometimes slight rain or snow with a southerly upper current (part of a general southerly

current), and the falling precipitation keeps the lower air damp, as is shown by the irregular masses of nimbus cloud, often joined in places to the alto-stratus above.

In the eight cases with warm sectors, observations of cirrus cloud motion were made either over or at the edges of the depressions, and the direction of motion of the cirrus and of the depressions agreed well, the difference not exceeding 30° and sometimes being within 10°. A larger number of observations is available for depressions moving northward from France, and these also show good agreement. The cirrus velocity is usually greater than that of the depression, whether directed towards west or north, and probably the middle layers of the troposphere are really the most important.

These continental depressions are warm and therefore shallow in the true three-dimensional sense, and not only in the fictitious sense in which the word is normally used. If a depression has a cold centre it extends to the cirrus level, so that the cirrus cloud motion at a particular place depends partly on the rotation round the centre, and not only on the motion of the system as a whole. In a depression with a warm sector there is better agreement, but a disturbing influence may arise from the presence of a wedge of high pressure at cirrus levels over the warm sector, especially in winter. For example there may be rapid cirrus motion from north-west in front of a depression moving north-east. The statistics given by Pick and Bowering* show that in 137 out of 162 cases, or 85 per cent., the angle between the cirrus motion and the motion of the depression did not exceed 90°. This is, of course, due to the general eastward motion, but a study of the abnormal tracks shows that the relation is real and not a mere coincidence. Attention may also be drawn to a recent note by Ramanathan and Ramakrishnan†, who show that Indian monsoon depressions move west or north-west in agreement with the upper winds, and with the observed gradients of temperature and pressure in the upper troposphere.

There may be some difference of opinion as to whether the upper wind or the closely related temperature distribution is the more fundamental. If we regard radiation as the primary factor, then the temperature is of outstanding importance, and in the case of the west-moving depressions one of the original causes is the heating of the continental air. As regards the short-period changes, the adjustments between temperature, pressure, and wind are mutual, and no one factor can be regarded as the cause of the others. Progress would seem to depend on the simultaneous handling of all three variables. There appears to be little chance of any accurate mapping of upper

*London, *Q.J.R. Meteor. Soc.* 57, p. 274.
†*Nature*, *London*, 129, p. 615.

winds over bad weather areas, but there remains the possibility of making progress from a knowledge of the distribution of pressure and temperature, together with a rough knowledge of the winds, and of the vertical motion deduced from the rainfall. C. K. M. DOUGLAS.

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, April 20th, at 49, Cromwell Road, South Kensington, Prof. S. Chapman, F.R.S., President, in the Chair.

J. N. L. Baker, Lecturer in Geography, Oxford.—The Climate of England in the Seventeenth Century.

The paper deals with three classes of evidence for climatic conditions in England during the century. A large number of descriptive writings provide evidence of a somewhat inconclusive character, and this can be supplemented by the reports of the Venetian Ambassadors, published in the Calendars of Domestic State Papers (Venetian) and elsewhere. The Calendars of Domestic State Papers furnish many scattered references, both to short periods and to long spells of weather, and from these a continuous account can sometimes be constructed. They also include important tables of winds covering the periods 1667-72 and 1675-78. The MS. diaries preserved in the Bodleian Library are also of value. That of Dr. Napier covers the period 1598-1635, but is very fragmentary: that of Elias Ashmole only extends from 1677 to 1685, but is unusually full. Most of this evidence has not previously been used and an attempt is here made to correlate it with the accepted rainfall figures of Townley and Derham and other records, such as the diaries of Evelyn and Pepys. It is shown that in a number of cases the older evidence is unreliable. At the same time it is pointed out that all the evidence is of an unscientific nature and that strict comparison with reliable evidence of modern times is apt to lead to erroneous conclusions.

C. W. G. Daking, B.Sc.—The Meteorology of Kamaran Island (Red Sea).

This paper deals with the outstanding features of the meteorology of a district in which observations have only been taken comparatively recently; but nevertheless some interesting facts have been brought to light, especially with regard to the upper winds, of which so little was known. The paper includes a climatological table giving averages for all elements over a period of several years. In most respects results show that the climate experienced there is typically tropical, but it is noteworthy that for so small an island the conditions are as trying as those experienced inland on the continents of Africa and Asia.

D. Brunt, M.A., B.Sc.—Notes on Radiation in the Atmosphere. The absorption spectra of water vapour and liquid water are discussed and compared, and the results shown for liquid water are applied to consider the justification for regarding cloud sheets and fog as black body radiators. Various series of observations of long wave radiation from the atmosphere are shown to fit very closely a formula only involving the absolute temperature and the vapour pressure. It is shown that the fall of temperature after sunset on clear nights is closely proportional to the square root of the time from sunset. The effects of absorption and radiation at the upper and lower levels of cloud sheets are discussed, and it is found that the tendency to instability is greatest for clouds of medium height.

Correspondence

To the Editor, *The Meteorological Magazine.*

A record Dry Winter at Guernsey

Rainfall records kept at Les Blanches, St. Martin's, Guernsey, since 1894, show that the "winter" six months just come to an end—that is the period from October, 1931, to March, 1932—has been the driest of the 38 winters covered by the observations.

There is nothing outstanding in the temperature record, which shows the season to have been one of average mildness. In the matter of rainfall, however, pronounced droughty conditions set in in the second week of September, at which time and as a result of excessive rains in July, August and the early days of September, a surplus of 8 inches was accumulated. This excess rainfall was steadily reduced in October, November and December when, normally, precipitation is heaviest in the island and it disappeared on Christmas Eve. The drought continued far into the New Year—in fact till towards the end of March, when temporarily or otherwise a break occurred.

In the table appended the statistics relate to the period, October-March, and give (1) the average mean temperature, rainfall and number of rain days of the 30 years, 1894-1923; (2) the figures of the past winter (the driest on record), which shows a rainfall deficit of 10.41 in.; and (3 and 4) the two previous driest winter of the 38 years.

	Mean temp. °F.	*Total rain* in.	*Rain Days*
Average (1894-1923) ...	46.4	21.45	121.7
Winter 1931-2 ...	46.8	11.04	78
,, 1897-8 ...	47.1	12.56	99
,, 1920-1 ...	47.9	12.96	97

From September 6th to March 19th, a period of 28 weeks, six of which were rainless—absolute droughts were registered in

October (19 days) and in February (16 days)—an excess rainfall was recorded in three weeks only, viz., those ended November 14th, January 9th and March 12th.

Associating as one does a generally low temperature with a dry winter it seems rather remarkable that in the three instances given of excessive drought each season was also distinctly mild.

BASIL T. ROWSWELL.

Les Blanches, Guernsey. April 9th, 1932.

Heavy Snow in April

An interesting example of a small local storm with very heavy precipitation in the form of snow and sleet occurred here on Monday, April 4th. During the early hours with a rising barometer, wind NW., moderate snow and sleet began to fall and continued until 1 p.m. Between 9 and 12 a.m. the fall of snow was very heavy, the flakes of snow being exceptionally large.

At this level, 486ft., about 3in. of heavy wet snow lay on the ground, the total in the gauge measuring 1.06in. while on the surrounding hills at a level of 900 to 1,000ft. snow lay to the depth of 7 to 9in., at 1,500ft. about 12in., and on the Black Mountains above 1,500ft. 12 to 14in. or more. Lower down the Golden Valley at Vowchurch, 450ft., between 2 and 3in. snow were reported on the ground, the total in the gauge measuring 1.15in. at 9 a.m.; at Kentchurch, 210ft., 2¼in. snow on ground and in gauge 1.34in.

Hereford had a fall of 0.50in. and Wormbridge, between Hereford and Pontrilas, 0.85in. The heaviest precipitation seems to have been about the centre of the Black Mountain district.

This is the heaviest fall of snow experienced in this district during this or last winter.

ROBERT GRAY.

Oaklands, Dorstone, Herefordshire. April 16th, 1932.

A remarkable Cirrus Band

At 5h. 40m. G.M.T. on Sunday, March 20th, 1932, approximately half an hour before sunrise, I observed what appeared to me to be a definite and single band of cirrus stretching from due north to south in a complete semicircle. The band tapered slightly at each extremity and its width was estimated to be about 5°. It was of a brilliant pink colour and the glow gave rise to considerable abnormal illumination. This glow was especially bright near the northern end, but both extremities were brighter than the portion in the zenith. The cirrus band

appeared quite thick and even dense in places and was not of the thin fibrous type usually associated with such bands.

Apart from the band the sky was clear but for 2/10ths of alto-cumulus lenticularis situated due east with its base about 2° above the horizon. Other conditions were as follows: temperature 35°F.; wind NW. 1 m.p.h.; average visibility three miles, but ground mist in valleys. Previous to the appearance of the band the sky had been cloudless for some hours.

When the sun rose at 6h. 10m. G.M.T. the band rapidly faded and was followed by the gradual appearance from north-north-west of a sheet of cirro-stratus.

The sketch shows the southern extremity of the "arc."

C. A. JUPP.

R.A.F. Station, Upper Heyford, Oxford. March 22nd, 1932.

Halo Phenomena, Armagh, April 27th, 1932

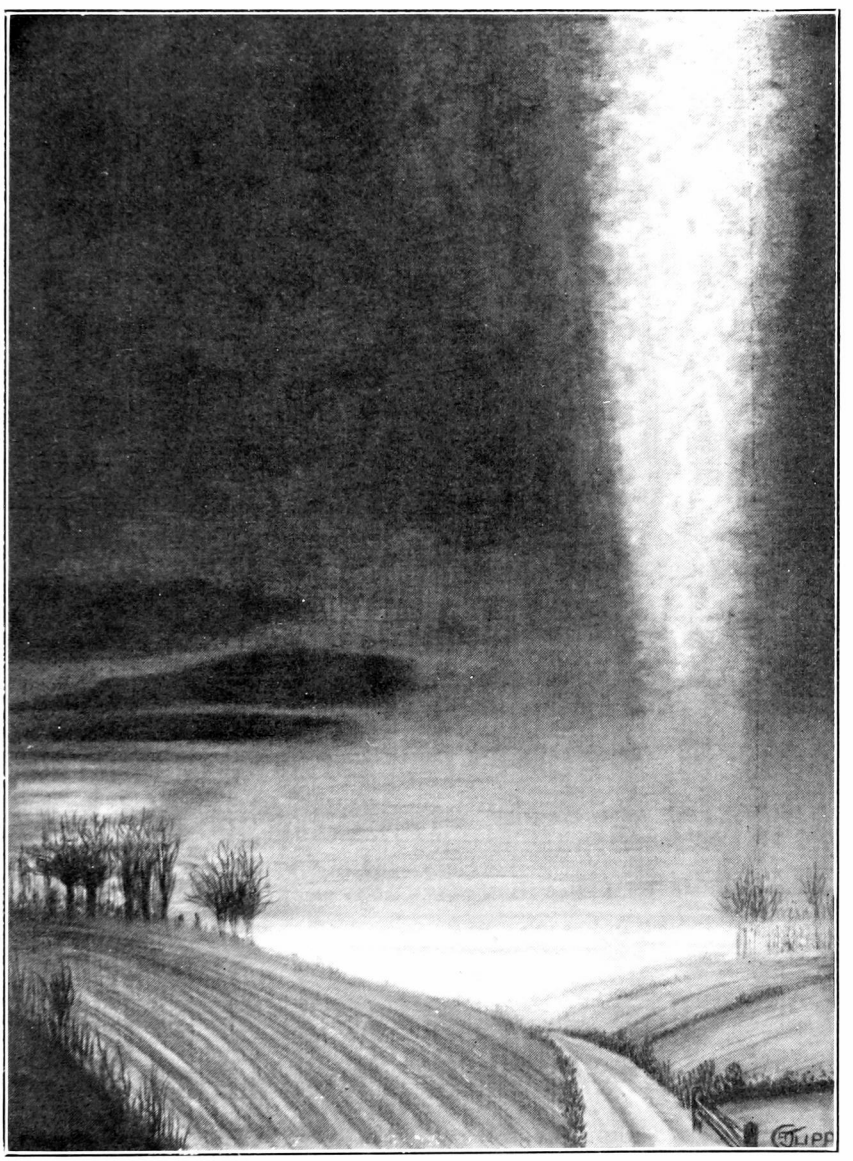
Rev. W. F. A. Ellison has forwarded a sketch of halo phenomena observed at Armagh between 9h. and 10h. on April 27th. The display included the halo of 22½° with parhelia, part of the mock-sun ring, the halo of 46° and traces of the upper arc of contact to the 46° halo which was described as very brilliant at the point of contact.

NOTES AND QUERIES

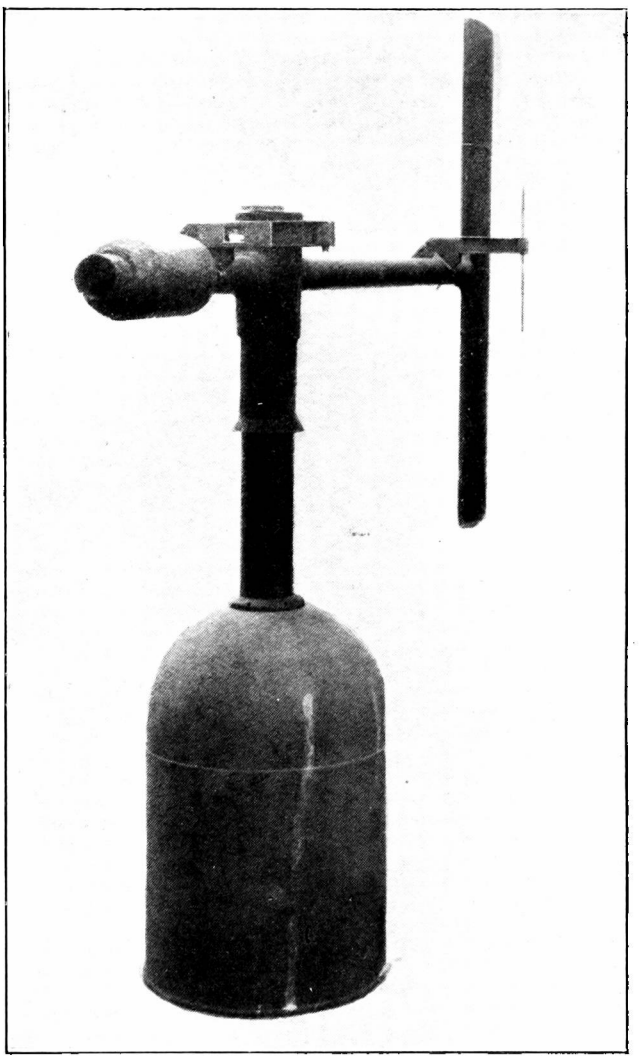
Sights for Anemometer Vane

A pair of sights has been constructed for use at Cardington to enable the anemometer to be orientated accurately. They have been found very convenient to use. Both sights are made of mahogany and have an inverted V seating at one end. This seating is faced with brass. A phosphor-bronze spring clip holds the seating securely to the horizontal tube of the vane. The foresight has at its further extremity a plug of brass with a small V-notch at top and bottom. This sight has also a spirit level, fitted so that when the bubble is central both the top and bottom surfaces of the projecting arm are horizontal. The backsight is similar in shape to the foresight but has no level, and in place of the V notches a vertical rod is held in a split bush.

To use the sights, the foresight is clipped to the horizontal part of the vane near the orifice and adjusted till the bubble is central. The backsight is similarly clipped on as far away from the foresight as convenient. Then looking across the top or bottom surfaces of the sights the backsight is adjusted till parallel with the foresight. The rod in the backsight is then



SOUTHERN EXTREMITY OF CIRRUS BAND, UPPER HEYFORD, MARCH 20TH, 1932.
(*Reproduced by the courtesy of Mr. C. A. Jupp*).



SIGHTS FOR ANEMOMETER VANE.

vertical and any part of it may be used in conjunction with the V notches to obtain a sight on a suitable object. The rod may be slid up or down as required. The sights may be used on either side of the vane.

A. Eric Mayers.

Maximum day Temperatures in early Spring

The lack of warm days during the first half of Spring, 1932, is shown in the following table covering data for this station for March and April during the past 19 years.

	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923
No. of days with temperature 60° F or over in March and April	16	5	9	4	11	4	12	17	1	12
Highest maximum in March and April in °F.	74	72	76	64	71	69	67	74	67	69
Mean day maximum in April in °F.	61	55	58	52	52	54	56	60	52	55

	1924	1925	1926	1927	1928	1929	1930	1931	1932
No. of days with temperature 60° F. or over in March and April	10	3	12	10	12	20	7	9	1
Highest maximum in March and April in °F.	75	66	72	72	70	73	68	66	63
Mean day maximum in April in °F.	55	55	58	57	55	54	55	53	53

On the last day of the month when a maximum of 63°F. was recorded, April just retrieved its reputation for giving at least one day with a temperature above 60°F. The early spring of 1922 with a single maximum of 67°F. on April 14th is, however, only slightly better. The mean day maximum of 53°F. for April, 1932, is also no lower than that for April, 1931, and somewhat higher than those for 1917, 1918 and 1922.

W. H. Bigg.

Reviews

Wetter und Wetterentwicklung. By Dr. H. von Ficker. Size 7½ × 5in., pp. 140. *Illus.* Berlin, J. Springer, 1932.

This is an excellent little book. It is one of a series of elementary text-books, and illustrates the fact that the best

popular work is written by a real master of the subject, provided that he has also the gift of simple exposition. The book is constructed on normal lines, and includes such questions as vertical stability and the effect of condensation. The last chapter contains a number of charts, most of which include the fronts, which are essential to an understanding of rainfall. Though fronts do not provide a complete explanation of rainfall, they are far more closely related to it than is the pressure distribution. They are now an indispensable part even of the most popular treatise, and though they involve a few additional technical terms, they present no special difficulties.

C. K. M. DOUGLAS.

Correlation between frost and the preceding meteorological conditions. By Barkat Ali and S. N. Naqvi. Calcutta, Indian Jour. Agric. Sci., 1, 1931, pp. 671-94.

In this useful study the authors follow the usual procedure of calculating relationships between the minimum temperature of the night on the one hand and the figures of dry- and wet-bulb temperatures and dew point on the preceding afternoon (at 16h.) on the other hand. The final results, obtained by partial correlation, are (for December and January):—

Minimum = ·392 (dew point) + ·116 (dry bulb) + 14·8; or
Minimum = ·837 (wet bulb) − ·130 (dry bulb) + 0·9.

These are based on 144 observations at Lahore and give a partial coefficient of ·73; the estimates of the minimum temperature have a probable error of about 1·7° F. Similar results are obtained for February.

On a few occasions the method fails, owing to the influx of air of a different character between the afternoon and the night, but the authors consider that these could be allowed for by a forecaster. Unfortunately, however, the numerical constants of the equations vary greatly with local conditions, and the necessary afternoon data are not yet available for calculating them for all districts in northern India.

The Annual Variation of Rainfall in New Zealand. By E. Kidson. New Zealand, J. Sci. Tech., Vol. XII, No. 5, pp. 268-72, Wellington, 1931.

It is shown that the distribution of the average annual rainfall amongst the months at stations in New Zealand is of three main types:—

(a) *The north and south-east of North Island and the north-east of South Island.*—Stations in these areas experience a pronounced maximum in winter. About 10·5 per cent. of the total rainfall falls in each of the three winter months, May, June and July, and rather less than 7 per cent. in January, November and December. The reason for this type of variation

in the far north is that in summer the high pressure belt of sub-tropical regions approaches that area. The variation is similar to that experienced in the southern half of Australia, and it persists further south in New Zealand in the eastern districts protected by mountainous ranges to the west.

(b) *The south-east of South Island.*—The second type is, broadly speaking, the reverse of the first. The wettest month is December, with about 10 per cent., and the winter months May, June, July and August are usually dry with about 7·5 per cent. of the annual amount. Rain is brought to this region by south-westerly winds, which have their maximum frequency in December and which give little rain in the sheltered districts further to the north-east.

(c) *The central portion of North Island and the western half of South Island.*—In this type the wettest month is October with about 10 per cent. and the driest month February with about 6·5 per cent., but there is a subsidiary maximum in August. These areas are mountainous and the rainfall mainly orographical. The westerly winds are strongest in October and weakest in February, with a secondary maximum in autumn or winter and a secondary minimum in August. The low rainfall in February is associated with the time of least activity in the general circulation, temperature having ceased rising, but scarcely yet begun to fall.

J. GLASSPOOLE.

The Occurrence of Thunderstorms in New Zealand. By E. Kidson and A. Thomson. New Zealand, J. Sci. Tech., Vol. XII, No. 4, pp. 193-206, Wellington, 1931.

The paper gives statistics and a map showing the distribution over New Zealand of the average number of thunderstorms per annum. There is a close relationship between this map and a map of the average annual rainfall.

The variation in the mean number of thunderstorms per year at selected stations has been correlated with the annual rainfall over New Zealand. The correlation coefficient is +0·42 for the 25 years 1905 to 1929. Conditions favourable to thunderstorm formation entail: (1) a high lapse rate, (2) a large amount of water vapour in these layers, and (3) absence of extensive sheets of high cloud. The conditions required are favourable for rain, but not rain of a general nature. This is the reason given for the small correlation between rainfall and thunderstorm frequency.

The average number of thunderstorm days in each month is also discussed. The variations from place to place are of particular interest in comparison with the variations in the incidence of rainfall throughout the year as shown in the previous paper.

J. GLASSPOOLE.

Obituaries

Alfred Judson Henry.—Professor A. J. Henry was born at New Bethlehem, Pa., on September 1st, 1858, and died on October 5th, 1931, at the age of 73. After completing his education at the Columbian University in Washington he enlisted in 1878 in the meteorological section of the Signal Corps, U.S. Army. In his early work of observing and telegraphing he quickly won a reputation for reliability, and in 1883 was assigned to the Chief Signal Office in Washington. In 1888 the Central Office was given civilian status and Henry rose rapidly to the position of Principal Meteorologist, which he held until his death. He was for some time Official Forecaster at Washington, later in charge of Mount Weather Observatory, and finally Editor of the *Monthly Weather Review*, in which capacity he became well known to British meteorologists. His work was distinguished for the accurate and critical presentation of facts, and his "Climatology of the United States" is still a mine of reference. Among his books and papers may also be mentioned "Rainfall in the United States," "Weather forecasting from synoptic charts," "The floods of 1913 in the rivers of the Ohio and lower Mississippi Valley," "Upper air investigations at Mount Weather, Va.," "Forest and stream-flow experiment at Wagon Wheel Gap, Colo," and "The Brückner cycle of climate oscillations in the United States," while he edited and wrote several chapters of the symposium on "Weather Forecasting in the United States." His wide knowledge was always at the service of his colleagues, and he has done much to encourage research among the younger meteorologists of the United States.

Louis Agricola Bauer.—The death of Dr. L. A. Bauer on April 12th, 1932, robs us of an outstanding figure in the study of terrestrial magnetism. Born in Cincinnati on January 26th, 1865, he was educated at the University of Cincinnati, where he received the degree of D.Sc. From 1887 to 1892 he served as astronomer and magnetic computer on the U.S. Coast and Geodetic Survey, and in 1895, after a period of study at the University of Berlin, where he received the Ph.D. for a thesis on the "Secular Variation of Terrestrial Magnetism" he became a teacher of mathematical physics in the University of Chicago. In 1897 he became assistant professor at Cincinnati, and in 1899 he was again appointed to the U.S. Coast Survey as Chief of the Terrestrial Magnetism Division, a post which he held until 1906. His activities were very numerous; he was Director of the Department of Terrestrial Magnetism from 1904 onwards, lecturer on terrestrial magnetism at Johns Hopkins University, and Editor of *Terrestrial Magnetism and Atmospheric Electricity* from its formation in 1896. He wrote

numerous papers on his chosen subject and attended meetings in all parts of the world; in 1913 he delivered the Halley Lecture at Oxford on "The earth's magnetism." He was for eight years Secretary of the Section of Terrestrial Magnetism and Electricity of the International Union of Geodesy and Geophysics, and became President of the Section in 1927, succeeding the late Dr. C. Chree.

Guillaume Bigourdan—M. Bigourdan was born on April 6th, 1851, at Sistels. Although primarily an astronomer, Director of the Bureau International de l'Heure, and since 1904 a member of the Astronomical Section of the Paris Academy of Sciences, he was also keenly interested in meteorology. In 1915 he published a study of the distribution of cloudiness in France, and in 1916 a valuable book on the climate of France. He also wrote several papers on the propagation of sound in the atmosphere. He died on February 28th.

We regret to announce the death, on April 17th, 1932, of Mr. J. F. Davison, Grade III Clerk in the Meteorological Office. Mr. Davison entered the Office from the Royal Naval Air Service in January, 1920.

The Weather of April, 1932

Pressure was above normal over west and north-east Canada, most of the North Atlantic, Greenland, west Iceland, Spitsbergen, the Iberian Peninsula, south Italy and north Africa, the greatest excess being 11.2mb. at Julianehaab. Pressure was below normal over east Iceland and Europe, with the exception of the countries quoted above, the greatest deficit being 10.9mb. at Utsire. Temperature was above normal in Spitsbergen and northern Scandinavia and below normal from southern Scandinavia to the Iberian Peninsula. Rainfall was below normal at Spitsbergen but above normal in Sweden, where it was as much as 100 per cent. above normal round Lake Maelar.

Over the British Isles the weather of April was unsettled and cold, day temperatures being generally below normal until the last few days. Rain was frequent but usually not heavy in amount, though the totals for the month were mostly above normal. Sunshine also was deficient except in parts of Scotland and Ireland. The complex depression situated over the British Isles on the 1st drifted slowly south-east, causing precipitation generally and snow and sleet as far south as Birmingham and Ross-on-Wye from the 1st—4th. Another disturbance followed, moving south-east from north-west Iceland to southern Scandinavia, and there ensued a period of squally westerly winds and local gales accompanied by showers of snow, sleet, hail, rain, and local thunder-

storms; snow was reported as far south as Oxford on the 7th. Much sun was experienced on the 4th—5th and 7th—8th, 11·7hrs. at Leuchars on the 7th, and 11·6hrs. at Torquay on the 5th. On the 8th the winds backed to SW. and the 9th was a mild day during this period of cold, 60°F. being reached at Cambridge and 59°F. in parts of Ireland. Yet another depression moved east across Great Britain causing heavy rain in north England and south Scotland on the 9th, 2·05in. at Borrowdale (Cumberland), and 1·49in. at Oughtershaw (Yorks.), and a renewal of strong winds and gales; Beaufort force 9 occurred at Lerwick on the 9th and Blacksod Point on the 10th. Snow was experienced over the country generally and extended this time south to Valentia, Waterford, Plymouth and Margate. A wedge of high pressure gave a brilliantly fine day on the 12th, 11·9hrs. at Scarboro', Southport and Chester, but weather deteriorated again in the west and north on the 13th at the approach of another Atlantic depression. Thunderstorms were experienced in the south and Midlands on the 12th and 14th. A change of type occurred about the 16th, when another wedge of high pressure passed south-east over the country. Bright sunny weather was enjoyed in Scotland and Ireland on the 16th—18th, 13·3hrs. at Malin Head on the 17th, but mainly dull, rainy conditions were experienced in south England. Unsettled weather was renewed in the north about the 19th and later throughout the country, as a depression off north-west Iceland moved slowly south-east. The weather for the ensuing week was showery, with local thunder and hail and some sleet or snow in Scotland, north England and the Midlands, but good sunshine records were also obtained, 13·4hrs. at Nairn on the 20th, 13·7hrs. at Renfrew on the 26th. On the 27th a depression approached the south-west coasts and remained almost stationary, while secondary disturbances moved round the main centre. Heavy rain fell locally on the 27th, 1·49in. at Fofanny (Co. Down). Conditions gradually became milder, and on the 30th 66°F. was registered at Greenwich and Woodhall Spa. Thunderstorms occurred locally in England and Ireland on the 29th and 30th, but generally they were fine sunny days. The distribution of bright sunshine for the month was as follows:—

	Total (hrs.)	Diff. from normal (hrs.)		Total (hrs.)	Diff. from normal (hrs.)
Stornoway	141	—13	Liverpool	131	—27
Aberdeen	147	—11	Ross-on-Wye	107	—43
Dublin	165	0	Falmouth	169	—15
Birr Castle	158	+ 4	Gorleston	139	—45
Valentia	154	— 6	Kew	117	—40

Miscellaneous notes on weather abroad culled from various sources.

Serious floods occurred in Roumania early in the month; about 50 people were drowned, and the damage was estimated at over £1,000,000. Sorokka in Bessarabia was for the most part destroyed. Heavy falls of snow were experienced in many parts of Spain at the beginning, and in Madrid it was intensely cold. "Mud-rain," which left on the ground slight traces of solid black material, fell at Florence, Genoa, and elsewhere in Italy on the 5th. The river ice was moving at Riga on the 9th, and navigation reopened at Helsingfors on the 11th. Falls of rain during the first half of the month considerably bettered the agricultural situation in Cyprus, which had become bad owing to drought. On account of the scarcity of snow during the early winter and its late melting due to the persistent cold, the level of the lakes in Switzerland was abnormally low, and there was a lack of electric power at the end of the month. (*The Times*, April 6th—30th.)

A tornado devastated the village of Majhirgati, near Khulna (Bengal), on the 26th, killing 4 people. Some 20 people were killed in a typhoon over the Philippines on the 30th. (*The Times*, May 3rd.)

A cyclone passed Port Louis (Mauritius) on the 10th but caused practically no damage. (*The Times*, April 12th.)

Warm weather was experienced in Manitoba during the early days of the month, but on the night of the 12th—13th a heavy snowstorm occurred in central Canada and floods were experienced in Quebec. Two feet of belated snow also fell in southern Alberta on the 21st. The total precipitation for the month was generally sufficient except in southern Saskatchewan. Seven people were reported to have been killed in Tennessee on the 25th by a tornado, which also swept over Arkansas and Alabama. Temperature was above normal over the United States generally, but fell below normal in the eastern States about the middle of the month. Rainfall was mainly below normal. (*The Times*, April 8th—26th, and *Washington D.C., U.S. Dept. Agric., Weekly Weather and Crop Bulletin.*)

Rainfall, April, 1932—General Distribution

England and Wales	156	per cent of the average 1881-1915.
Scotland	160	
Ireland	118	
British Isles	149	

Rainfall: April, 1932: England and Wales.

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden Square	2·28	148	*Leics* .	Belvoir Castle.....	2·10	137
Sur .	Reigate, Alvington ...	2·37	142	*Rut* .	Ridlington	3·06	199
Kent .	Tenterden, Ashenden...	2·32	143	*Linc* .	Boston, Skirbeck	3·06	227
,, .	Folkestone, Boro. San .	3·47	...	,, .	Cranwell Aerodrome ...	1·86	141
,, .	Margate, Cliftonville...	1·50	111	,, .	Skegness, Marine Gdns	2·54	189
,, .	Sevenoaks, Speldhurst	2·71	...	,, .	Louth, Westgate	2·60	156
Sus .	Patching Farm	2·39	137	,, .	Brigg, Wrawby St. ...	2·44	...
,, .	Brighton, Old Steyne..	1·73	107	*Notts* .	Worksop, Hodsock ...	2·17	148
,, .	Heathfield, Barklye ...	3·02	163	*Derby* .	Derby, L. M. & S. Rly.	2·80	172
Hants.	Ventnor, Roy. Nat. Hos.	2·47	147	,, .	Buxton, Devon Hos. ...	5·44	185
,, .	Fordingbridge, Oaklnds	3·63	198	*Ches* .	Runcorn, Weston Pt...	3·02	175
,, .	Ovington Rectory	3·85	203	,, .	Nantwich, Dorfold Hall	3·32	...
,, .	Sherborne St. John ...	3·10	175	*Lancs*.	Manchester, Whit Pk.	2·93	153
Berks .	Wellington College ...	3·25	202	,, .	Stonyhurst College ...	3·80	140
,, .	Newbury, Greenham...	2·68	147	,, .	Southport, Hesketh Pk	2·77	150
Herts .	Welwyn Garden City...	2·55	...	,, .	Lancaster, Strathspey	3·05	...
Bucks.	H. Wycombe, Flackwell	2·62	...	*Yorks*.	Wath-upon-Dearne ...	2·29	145
Oxf .	Oxford, Mag. College...	1·99	129	,, .	Bradford, Lister Pk. ...	3·14	156
Nor .	Pitsford, Sedgebrook...	3·71	242	,, .	Oughtershaw Hall	6·12	...
,, .	Oundle.....	2·59	...	,, .	Wetherby, Ribston H.	2·45	139
Beds .	Woburn, Crawley Mill	2·21	147	,, .	Hull, Pearson Park ...	3·11	199
Cam .	Cambridge, Bot. Gdns.	2·24	165	,, .	Holme-on-Spalding ...	2·06	...
Essex .	Chelmsford, County Lab	1·96	153	,, .	West Witton, Ivy Ho.	2·80	130
,, .	Lexden Hill House ...	2·13	...	,, .	Felixkirk, Mt. St. John	1·23	74
Suff .	Haughley House.....	1·94	...	,, .	Pickering, Hungate ...	1·88	113
,, .	Campsea Ashe.....	2·94	208	,, .	Scarborough	1·79	115
Norf .	Norwich, Eaton.....	...	...	,, .	Middlesbrough	·76	56
,, .	Wells, Holkham Hall	3·18	248	,, .	Balderdale, Hury Res.	4·43	...
,, .	Swaffham, The Villa...	3·66	239	*Durh* .	Ushaw College	1·85	98
Wilts.	Devizes, Highclere.....	3·41	179	*Nor* .	Newcastle, Town Moor	1·06	65
,, .	Bishops Cannings	3·50	173	,, .	Bellingham, Highgreen	3·29	152
Dor .	Evershot, Melbury Ho.	3·43	145	,, .	Lilburn Tower Gdns...	2·18	110
,, .	Creech Grange	3·07	142	*Cumb* .	Geltsdale.....	3·04	...
,, .	Shaftesbury, Abbey Ho.	2·59	123	,, .	Carlisle, Scaleby Hall	2·64	135
Devon.	Plymouth, The Hoe...	3·22	142	,, .	Borrowdale, Seathwaite	11·25	163
,, .	Launceston, Werringt'n	3·28	...	,, .	Borrowdale, Moraine...	9·08	...
,, .	Holne, Church Pk. Cott.	5·99	165	,, .	Keswick, High Hill...	4·68	...
,, .	Cullompton.....	3·15	139	*West* .	Appleby, Castle Bank	3·15	162
,, .	Sidmouth, Sidmount...	...	...	*Glam* .	Cardiff, Ely P. Stn. ...	4·00	158
,, .	Filleigh, Castle Hill ...	2·38	...	,, .	Treherbert, Tynywaun	8·17	...
,, .	Barnstaple, N. Dev. Ath	2·00	94	*Carm*.	Carmarthen Friary ...	3·45	126
,, .	Dartm'r, Cranmere Pool	3·60	...	*Pemb* .	Haverfordwest, School	2·99	114
Corn .	Redruth, Trewirgie ...	2·90	101	*Card* .	Aberystwyth	2·27	...
,, .	Penzance, Morrab Gdn.	3·49	144	,, .	Cardigan, County Sch.	2·29	...
,, .	St. Austell, Trevarna...	3·99	141	*Brec* .	Crickhowell, Talymaes	5·60	...
Soms .	Chewton Mendip	4·58	154	*Rad* .	Birm W. W. Tyrmynydd	6·28	170
,, .	Long Ashton	3·56	163	*Mont* .	Lake Wyrnwy.....	7·43	246
,, .	Street, Millfield.....	2·49	124	*Denb* .	Llangynhafal	4·50	236
Glos .	Blockley	3·28	...	*Mer* .	Dolgelly, Bryntirion...	4·50	126
,, .	Cirencester, Gwynfa ...	2·94	157	*Carn* .	Llandudno	2·94	162
Here .	Ross, Birchlea.....	2·87	151	,, .	Snowdon, L. Llydaw 9	12·35	...
,, .	Ledbury, Underdown..	3·09	170	*Ang* .	Holyhead, Salt Island	...	...
Salop .	Church Stretton.....	5·07	235	,, .	Lligwy.....	3·23	...
,, .	Shifnal, Hatton Grange	3·46	206	*Isle of Man*			
Worc .	Ombersley, Holt Lock	3·37	222		Douglas, Boro' Cem. ...	3·78	153
War .	Birmingham, Edgbaston	3·24	186	*Guernsey*			
Leics .	Thornton Reservoir ...	3·39	199		St. Peter P't. Grange Rd.	2·94	146

Rainfall: April, 1932: Scotland and Ireland

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Wigt .	Pt. William, Monreith	2·65	120	*Suth* .	Melvich	2·58	...
,, .	New Luce School.....	5·23	197	,, .	Loch More, Achfary...	9·01	186
Kirk .	Carsphairn, Shiel	7·35	177	*Caith* .	Wick	2·97	149
Dumf .	Dumfries, Crichton, R.I	2·54	...	*Ork* .	Pomona, Deerness.....	3·41	164
,, .	Eskdalemuir Obs.	5·30	156	*Shet* .	Lerwick	4·16	182
Roxb .	Branxholm	3·10	164	*Cork* .	Caheragh Rectory	2·47	...
Selk .	Ettrick Manse.....	5·38	154	,, .	Dunmanway Rectory .	3·31	80
Peeb .	West Linton	3·89	...	,, .	Ballinacurra	2·67	103
Berk .	Marchmont House.....	2·29	113	,, .	Glanmire, Lota Lo.....	2·87	103
Hadd .	North Berwick Res....	1·27	91	*Kerry* .	Valentia Obsy.....	3·72	101
Midl .	Edinburgh, Roy. Obs.	2·07	141	,, .	Gearahameen	8·10	...
Lan .	Auchtyfardle	3·03	...	,, .	Killarney Asylum	4·30	130
Ayr .	Kilmarnock, Kay Pk. .	3·29	...	,, .	Darrynane Abbey	3·15	91
,, .	Girvan, Pinmore.....	3·49	117	*Wat* .	Waterford, Gortmore...	1·80	72
Renf .	Glasgow, Queen's Pk. .	3·20	163	*Tip* .	Nenagh, Cas. Lough ..	2·74	109
,, .	Greenock, Prospect H.	5·82	160	,, .	Roscrea, Timoney Park	1·93	...
Bute .	Rothesay, Ardencraig.	5·04	169	,, .	Cashel, Ballinamona ...	2·52	101
,, .	Dougarie Lodge.....	4·47	...	*Lim* .	Foynes, Coolnanes.....	2·94	121
Arg .	Ardgour House	7·37	...	,, .	Castleconnel Rec.....	2·83	...
,, .	Glen Etive	8·01	144	*Clare* .	Inagh, Mount Callan...	4·19	...
,, .	Oban	3·71	118	,. .	Broadford, Hurdlest'n.	2·01	...
,, .	Poltalloch	4·46	152	*Wexf* .	Gorey, Courtown Ho...	3·10	141
,, .	Inveraray Castle	8·13	177	*Kilk* .	Kilkenny Castle.....	1·91	87
,, .	Islay, Eallabus	...	...	*Wic* .	Rathnew, Clonmannon	2·56	...
,, .	Mull, Benmore	...	...	*Carl* .	Hacketstown Rectory..	3·27	123
,, .	Tiree	3·41	...	*Leix* .	Blandsfort House	3·27	125
Kinr .	Loch Leven Sluice.....	2·35	125	,, .	Moudtmellick.....	3·62	...
Perth .	Loch Dhu	8·50	179	*Off'ly* .	Birr Castle	2·22	103
,, .	Balquhidder, Stronvar	4·55	...	*Kild'r.*	Monasterevin	...	...
,, .	Crieff, Strathearn Hyd.	3·37	154	*Dubl* .	Dublin, FitzWm. Sq....	2·43	128
,, .	Blair Castle Gardens...	3·73	177	,, .	Balbriggan, Ardgillan.	2·29	116
Angus.	Kettins School	3·49	210	*Me'lb* .	Beauparc, St. Cloud ...	2·46	...
,, .	Dundee, E. Necropolis	2·22	131	,. .	Kells, Headfort.....	2·38	95
,, .	Pearsie House.....	3·01	...	*W.M* .	Moate, Coolatore	2·03	...
,, .	Montrose, Sunnyside...	2·78	153	,, .	Mullingar, Belvedere...	2·69	113
Aber .	Braemar, Bank	3·73	115	*Long* .	Castle Forbes Gdns....	2·41	101
,, .	Logie Coldstone Sch....	3·15	157	*Gal* .	Ballynahinch Castle...	3·82	108
,, .	Aberdeen, King's Coll.	2·94	157	,, .	Galway, Grammar Sch.	2·78	...
,, .	Fyvie Castle	4·04	189	*Mayo* .	Mallaranny.....	5·17	...
Moray .	Gordon Castle.....	2·97	170	,, .	Westport House.....	3·80	141
,, .	Grantown-on-Spey.....	4·47	227	,, .	Delphi Lodge.....	6·80	118
Nairn.	Nairn, Delnies	3·13	209	*Sligo* .	Markree Obsy.....	4·58	173
Inv. .	Ben Alder Lodge.....	5·10	...	*Cav'n* .	Belturbet, Cloverhill...	2·65	115
,, .	Kingussie, The Birches	3·58	...	*Ferm* .	Enniskillen, Portora...	2·55	...
,, .	Loch Quoich, Loan.....	11·03	...	*Arm* .	Armagh Obsy.....	2·38	113
,, .	Glenquoich	9·72	150	*Down* .	Fofanny Reservoir.....	5·22	...
,, .	Inverness, Culduthel R.	3·29	...	,, .	Seaforde	3·57	136
,, .	Arisaig, Faire-na-Squir	3·69	...	,, .	Donaghadee, C. Stn....	3·15	156
,, .	Fort William, Glasdrum	5·90	...	,, .	Banbridge, Milltown...	2·35	...
,, .	Skye, Dunvegan.....	5·90	...	*Antr* .	Belfast, Cavehill Rd....	3·71	...
,, .	Barra, Skallary	3·89	...	,, .	Glenarm Castle	4·98	...
R & C .	Alness Ardros Cas.....	5·75	237	,, .	Ballymena, Harryville	4·44	168
,, .	Ullapool	5·02	162	*Lan* .	Londonderry, Creggan	4·57	178
,, .	Achnashellach	7·65	...	*Tyr* .	Omagh, Edenfel.....	3·28	125
,, .	Stornoway	3·87	...	*Don* .	Malin Head.....	3·87	...
Suth .	Lairg	4·10	177	,, .	Dunfanaghy	4·18	...
,, .	Tongue	4·23	161	,, .	Killybegs, Rockmount.	3·15	87

Climatological Table for the British Empire, November, 1931

STATIONS	PRESSURE		TEMPERATURE							Relative Humidity	Mean Cloud Am'nt	PRECIPITATION			BRIGHT SUNSHINE	
			Absolute		Mean Values				Mean							
	Mean of Day M.S.L.	Diff. from Normal	Max.	Min.	Max.	Min.	½ max. and min.	Diff. from Normal	Wet Bulb			Am'nt	Diff. from Normal	Days	Hours per day	Percentage of possible
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F	°F.	%	0—10	in.	in.			
London, Kew Obsy. ..	1009·9	— 4·7	61	32	51·4	41·0	46·2	+ 2·2	43·7	92	8·5	2·14	— 0·08	15	2·0	22
Gibraltar.....	1018·6	+ 0·6	75	47	68·2	56·0	62·1	+ 1·6	55·9	86	6·1	3·82	— 2·57	11	..	..
Malta	1017·6	+ 1·7	74	54	68·4	59·7	64·1	+ 0·2	59·4	77	7·4	3·57	0·00	13	4·9	48
St. Helena	1014·3	— 0·2	68	52	61·1	54·3	57·7	— 1·9	55·4	94	9·8	1·84	..	17	..	..
Sierra Leone	1012·2	+ 1·3	89	67	87·1	70·4	78·7	— 2·5	77·9	84	5·5	5·05	— 0·07	13	..	..
Lagos, Nigeria	1009·9	— 0·9	89	72	86·7	76·1	81·4	0·0	77·3	82	8·5	2·24	— 0·34	14	..	..
Kaduna, Nigeria	1011·6	— 1·5	97	55	93·8	60·7	77·3	+ 1·1	66·8	54	4·5	1·64	+ 1·52	2	..	..
Zomba, Nyasaland ..	1008·8	— 0·1	94	60	83·5	65·3	74·4	— 1·2	..	69	6·3	6·10	+ 1·02	12	..	..
Salisbury, Rhodesia ..	1009·0	— 0·3	87	56	77·8	59·9	68·9	— 1·8	61·2	65	6·5	6·54	+ 2·94	14	5·6	43
Cape Town.....	1014·9	— 0·9	102	49	79·2	59·0	69·1	+ 4·7	60·8	64	3·3	0·13	— 0·96	3	..	..
Johannesburg	1012·4	+ 0·8	88	47	74·9	53·9	64·4	+ 0·7	57·0	68	5·2	4·62	— 0·34	15	7·7	57
Mauritius	1014·7	— 1·4	87	61	82·6	68·5	75·6	+ 0·1	71·2	68	7·7	3·82	+ 2·24	22	6·6	51
Calcutta, Alipore Obsy.	1013·9	+ 0·6	87	61	82·0	65·9	73·9	+ 0·4	67·4	91	2·9	5·04	+ 4·39	3*	..	..
Bombay	1011·3	— 0·7	94	71	90·3	74·2	82·3	+ 1·7	71·9	75	2·2	2·40	+ 1·95	2*	..	..
Madras	1011·7	+ 0·4	87	69	84·5	73·4	78·9	0·0	74·9	86	7·0	16·66	+ 3·05	16*	..	..
Colombo, Ceylon	1010·7	+ 0·7	87	71	85·6	73·5	79·5	— 0·5	76·3	80	5·7	15·74	+ 3·98	24	7·1	60
Singapore	..	..	92	71	87·4	73·6	80·5	— 0·1	76·1	79	7·3	10·48	+ 0·57	18	4·9	41
Hongkong	1016·4	— 1·1	82	56	76·0	66·1	71·1	+ 1·5	63·1	58	3·8	0·97	— 0·73	3	8·1	74
Sandakan	..	..	89	73	87·2	74·3	80·7	— 0·2	77·2	83	..	11·38	— 3·34	18	..	..
Sydney, N.S.W.	1015·3	+ 1·5	86	48	72·6	59·7	66·1	— 0·9	62·1	68	6·5	3·05	+ 0·20	15	8·1	58
Melbourne	1016·3	+ 1·9	91	43	69·7	50·7	60·2	— 1·1	55·0	61	7·6	3·93	+ 1·70	14	4·6	33
Adelaide	1016·9	+ 1·7	96	45	77·2	55·7	66·5	— 0·5	56·0	40	6·5	0·87	— 0·28	6	7·9	57
Perth, W. Australia ..	1017·3	+ 1·9	95	46	79·2	57·1	68·1	+ 2·0	58·2	44	3·0	0·03	— 0·77	2	10·7	77
Coolgardie	1016·4	+ 3·3	99	43	79·0	52·1	65·5	— 5·2	54·9	43	3·1	1·65	+ 1·06	6	..	..
Brisbane	1014·8	+ 0·2	89	58	80·2	64·3	72·3	— 1·2	66·6	65	7·0	8·51	+ 4·76	15	7·5	56
Hobart, Tasmania....	1012·8	+ 3·2	77	39	63·2	47·6	55·4	— 1·8	49·6	58	7·7	2·85	+ 0·38	11	6·0	41
Wellington, N.Z.	1016·1	+ 4·0	70	37	62·9	51·6	57·3	+ 0·5	54·2	73	5·6	2·61	— 0·91	9	8·8	61
Suva, Fiji	1011·3	+ 0·2	88	69	83·9	72·5	78·2	+ 1·1	73·9	77	6·7	10·41	+ 0·62	24	6·0	46
Apia, Samoa	1009·1	— 0·4	88	70	86·1	72·5	79·3	+ 0·6	75·8	74	6·0	5·82	— 4·01	10	7·8	61
Kingston, Jamaica ..	1010·4	— 2·0	91	68	86·2	71·6	78·9	— 0·4	70·9	89	5·0	3·94	+ 0·91	8	2·9	26
Grenada, W.I.	1013·6	+ 3·0	90	72	88·0	74·6	81·3	+ 1·8	74·6	76	5·4	14·39	+ 5·93	30	..	..
Toronto	1019·0	+ 1·7	66	28	51·8	39·8	45·8	+ 8·8	40·8	84	7·5	2·38	— 0·25	11	2·5	26
Winnipeg	1014·8	— 2·6	66	—1	37·5	23·2	30·3	+ 9·0	..	..	5·8	0·35	— 0·72	3	3·6	40
St. John, N.B.	1019·0	+ 4·4	63	17	47·9	36·2	42·1	+ 5·4	37·4	83	6·3	1·56	— 2·85	15	3·7	39
Victoria, B.C.	1017·5	+ 1·6	56	31	46·5	38·6	42·5	— 2·0	39·8	84	6·3	5·28	— 0·13	15	3·7	40

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.